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DECUS NO.	8-280
TITLE	GENERAL SORTING PROGRAM
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DATE	March 2, 1970
SOURCE LANGUAGE	PAL III

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GENERAL SORTING PROGRAM

DECUS Program Library Write-up

DECUS No. 8-280

1. Abstract

This programme will sort alpha-numeric records into ascending order. Input-Output is via High Speed Paper Tape peripherals, or the ASR 33 teletype. To improve the use of the available storage space 2 characters are stored per 12 bit computer word. The user must at the time of running, specify the number of character positions to be reserved for each record, and the number of characters to be sorted on. Records longer than the specified length are truncated, records shorter are padded out with blanks.

2. Configuration

2.1 PDP-8 series computer with basic 4K memory.

2.2 ASR 33 teletype.

2.3 High speed paper tape reader (HSR) - optional.

2.4 High speed paper tape punch (HSP) - optional.

3. Core Requirements

3.1 Programme :- 0 to 641

3.2 Data :- 642 to 7600.

N.B. The programme sets up a working area one record length from the end of the data area. When the input data attempts to overflow this area, the sort subroutine is automatically entered.

4. Method of Operation

The programme is loaded under the normal procedure with the DEC Binary Loader. When the programme is started, all available storage space is set to zero, the record and sort details are entered via the switch register. The data tape can be read in through the HSR, or teletype reader, the programme will use the HSR if the data tape is waiting in it, if not the programme assumes the teletype is to be used.

Each data record is terminated by a carriage return line feed (cr/lf) and the last record by a cr/lf followed by a dollar sign. The first address where the start of the next record will be stored will always be one record length memory words from the start of the last record. Therefore the ends of records longer than the specification will be overwritten. The sort subroutine is entered when the dollar sign is encountered or when the available storage is filled, record (N) and and record (N + 1) are compared (paragraph 10) if record (N) is lower or equal to record (N + 1) they are left in the same order, record (N + 1) and record (N + 2) will be compared next.

If a move is made backwards N is checked for zero, if it is, it is reset to 1. If a move is made forwards a check is made to see if N is equal to the total number of records, if it is the sort is complete. The output peripheral can be selected from the switch register and can be either the HSP or the teletype. The records are put out in ascending order after a short length of leader. If there are any blank locations at the end of any records they are punched as spaces. This ensures that the output is of fixed record length. Short length of trailer is punched after the end of the last record.

If the continue button is pressed, and a new data tape is ready in the appropriate reader, the sort can be repeated for the same specification.

See also, General Flow Diagram.

5. Operating Procedure

5.1 Load the programme with the DEC Binary Loader (See Digital -8-2-U

5.2 Load address 200.

5.3 Press Start.

5.4 Load the data tape into the appropriate tape reader.

5.5 Load the record length in octal, onto the switch register.

5.6 Press Continue.

5.7 Load the number of characters to be sorted on, in octal, onto the switch register.

5.8 Press continue.

The data tape will be read in, and the records sorted when the dollar sign is encountered. When the sort is complete, the computer will halt.

5.9 Set bit 11 of the switch register to a '1' for HSP output, or to an '0' for ASR 33.

5.10 Press Continue.

If the computer halts immediately the sort length entered is greater than the record length, go back to step 5.2

When all records have been put out, the computer will halt. To repeat for new data with the same conditions, press continue. If new conditions are required, goto step 5.2

6. Significant Characters

← Erase current record.

$ Commence Sort.

Carriage Return - Terminate current record. (If no data has gone between this cr and the last, this one will be ignored, i.e. no blank record.

7. Limitations

The following characters are ignored :-

Rub out
Line Feed
Blank Tape.

The @ character is converted to spaces at output.

If the record length or the sort length are odd numbers the higher even number is taken.

8. Execution Time

Large numbers of records do take a significant time to sort, especially if a PDP-8/S is used where the time could possibly extend into minutes.

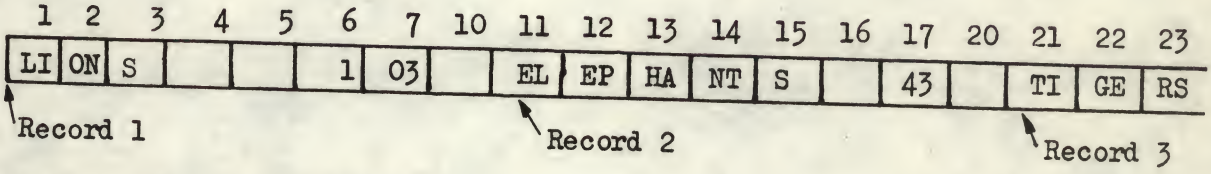
9. Storage Layout Examples

Example records :-

Lions	103
Elephants	43
Tigers	29

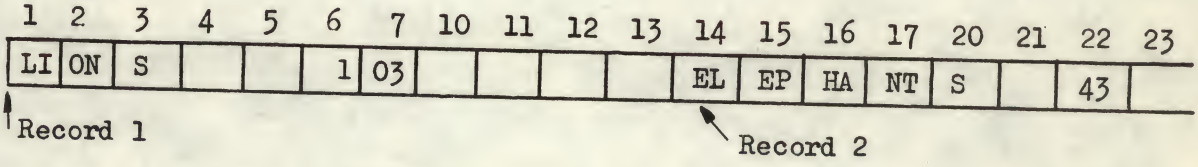
With record length 17 (octal).

Locations



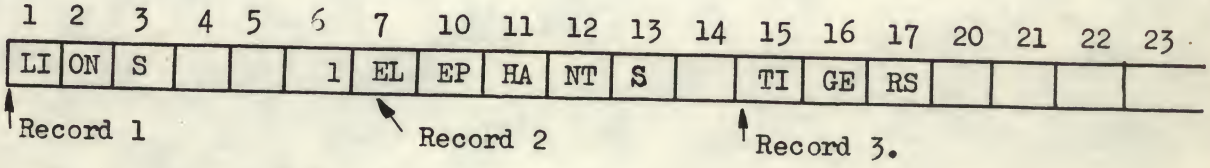
With Record Length 25 (Octal)

Locations



With Record Length 12 (Octal)

Locations



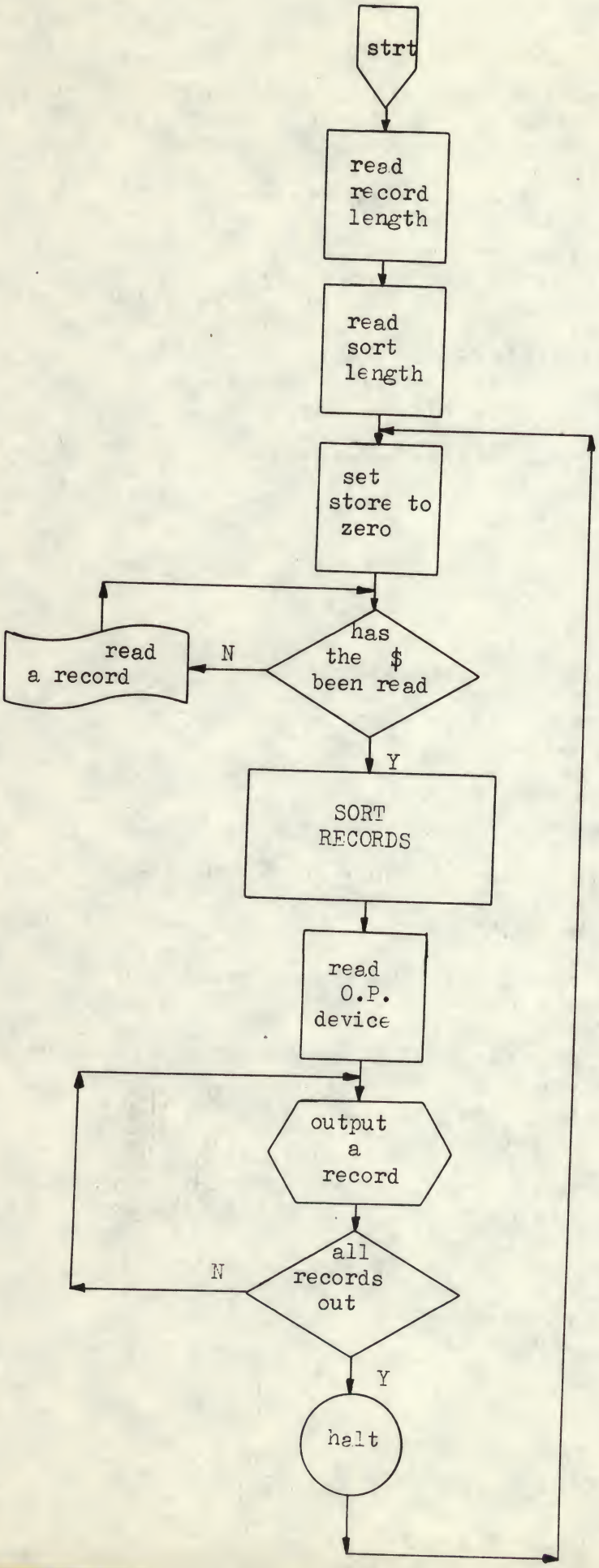
10. Sort Subroutine - Record Comparison

The sort subroutine compares records by subtracting a word in record (N) from the corresponding word in record (N + 1). If they are equal, it moves to the next word in each record until an unequal answer is reached, or the sort length is expired.

i.e.

	1	2	3	4	5	6	
record (N)	TI	GE	RS	2	56		
Octal Equivalent	2411	0705	2223	4062	6566	0000	
Record (N + 1)	TI	GE	RS		43		
Octal Equivalent	2411	0705	2223	4040	6463	0000	

If the sort length was 6, the first 3 words of each record would be compared (all identically equal). Therefore, the records would be left in this order. If the sort length was 12 (10 in decimal) the first 5 words would be compared and at word 4, it would be found that record (N) has a higher value than record (N + 1). Therefore, the records would change order.



General Flow Diagram

```
                / GENERAL SORT PROGRAM FOR PDP-8 SERIES COMPUTERS.
                / M. J. RAYMOND.     MULLARDS, SOUTHAMPTON.
                / FEBRUARY 1970.
                /
                /                  ******************
                /
                / START ADDRESS :- 200.
                / IF HSR IN USE, LOAD DATA TAPE.
                / ENTER RECORD LENGTH ONTO S.R., PRESS CONTINUE.
                / ENTER SORT LENGTH ONTO S.R., PRESS CONTINUE.
                / INPUT DATA. (IF ASR33 IS IN USE.)
                / SET S.R. TO 0001 FOR HSP OUTPUT,
                /             0000 FOR ASR33.
                /
                /                  ******************
                /


                / PAGE 0.
                *1
0001  0000  STORE,     0
0002  0000             0
0003  0000  COUNT,     0
0004  0000  OUT,       0
0005  0000  DELAY,     0
0006  0640  K577,      DATA-1
0007  0641  K600,      DATA
0010  0000  AUTO,      0

                *20
                / SUBROUTINE TO PRINT HALF A PACKED WORD.
0020  0000  UNTRIM,    0
0021  0132             AND K77              / EXTRACT JUNIOR HALF.
0022  7450             SNA
0023  5037             JMP BLANK            / DATA = BLANK.
0024  3133             DCA INCOME
0025  1133             TAD INCOME
0026  0134             AND K40              / TEST FOR ALPHA OR NUM.
0027  7650             SNA CLA
0030  1135             TAD K100             / ADD BIAS.
0031  1136             TAD K200
0032  1133             TAD INCOME
0033  4042  CALL,      JMS OUT              / PUNCH CHARACTER.
0034  2003             ISZ COUNT            / ALL CURRENT RECORD OUT ?
0035  5420             JMP I UNTRIM
0036  5537             JMP I XEDR           / YES.
0037  7200  BLANK,     CLA
0040  1154             TAD K240
0041  5033             JMP CALL
```

```
                    / SUBROUTINE TO OUTPUT A CHARACTER.
0042  0000  OUT,     0
0043  3133            DCA INCOME
0044  1120            TAD PFLAG
0045  7650            SNA CLA                 / TEST FOR OUTPUT DEVICE.
0046  5055            JMP TTY
0047  1133            TAD INCOME              / HSP.
0050  6026            PLS
0051  6021            PSF
0052  5051            JMP .-1
0053  7200            CLA
0054  5442            JMP I OUT               / EXIT.
0055  1133  TTY,      TAD INCOME
0056  4060            JMS TYPE                / TELETYPE.
0057  5442            JMP I OUT               / EXIT.

                    / SUBROUTINE TO TYPE A CHARACTER.
0060  0000  TYPE,     0
0061  6046            TLS
0062  6041            TSF
0063  5062            JMP .-1
0064  7200            CLA
0065  5460            JMP I TYPE

                    / SUBROUTINE TO READ A CHARACTER FROM TELETYPE.
0066  0000  SSR,      0
0067  6031            KSF
0070  5067            JMP .-1
0071  6036            KRB
0072  5466            JMP I SSR

                    / SUBROUTINE TO READ A CHARACTER FROM HSR.
0073  0000  HSR,      0
0074  6014            RFC
0075  6011            RSF
0076  5075            JMP .-1
0077  6012            RRB
0100  5473            JMP I HSR

                    / SUBROUTINE TO OUTPUT CR-LF.
0101  0000  OCRLF,    0
0102  1145            TAD K215
0103  4042            JMS OUT
0104  1146            TAD K212
0105  4042            JMS OUT
0106  5501            JMP I OCRLF

                    / SUBROUTINE TO PRINT CR-LF.
0107  0000  CRLF,     0
```

```
0110  1145          TAD K215
0111  4060          JMS TYPE
0112  1146          TAD K212
0113  4060          JMS TYPE
0114  5507          JMP I CRLF

0115  6000  M2000,  -2000
0116  0600  READX,  READ
0117  0000  RFLAG,  0
0120  0000  PFLAG,  0
0121  0000  RECORD,  0
0122  0000  CONTRL,  0
0123  7741  M37,    -37
0124  1040  K1040,  1040
0125  0200  MTOP,   -7600
0126  0400  SORTII, SORT
0127  0001  K1,     1
0130  7660  M120,   -120
0131  0000  FLAG,   0
0132  0077  K77,    77
0133  0000  INCOME, 0
0134  0040  K40,    40
0135  0100  K100,   100
0136  0200  K200,   200
0137  0357  XEOR,   EOR
0140  7401  M377,   -377
0141  0133  K133,   133
0142  0317  DOLLAR, STANBY
0143  0027  K27,    27
0144  0003  K3,     3
0145  0215  K215,   215
0146  0212  K212,   212
0147  0000  RECLEN, 0
0150  0000  SORTH,  0
0151  0641  SORTL,  DATA
0152  0000  SORLEN, 0
0153  0000  SORST,  0
0154  0240  K240,   240

0155  7104  XKP,    RAL CLL
0156  7041          CIA
0157  5560          JMP I .+1
0160  0345          NEXT-1

0161  1131  KV2,    TAD FLAG
0162  7650          SNA CLA
0163  5567          JMP I .+4
0164  2121          ISZ RECORD
0165  5566          JMP I .+1
0166  0313          IPTERM+1
```

0167 0314 IPTERM+2

```
                / PAGE 1.
                *200
0200  6032              KCC
0201  7300              CLA CLL
0202  7402              HLT
0203  7604              LAS
0204  7001              IAC
0205  7110              RAR CLL
0206  3147              DCA RECLEN          /READ RECORD LENGTH FROM SWIT
0207  7402              HLT
0210  7604              LAS
0211  7001              IAC
0212  7110              RAR CLL
0213  3152              DCA SORLEN          / READ SORT KEY LENGTH FROM SR
0214  1147              TAD RECLEN
0215  1125              TAD MTOP
0216  3125              DCA MTOP
0217  1006  START,      TAD K577
0220  3010              DCA AUTO
0221  1124              TAD K1040
0222  3003              DCA COUNT
0223  3410              DCA I AUTO          / CLEAR ALL DATA AREA.
0224  2003              ISZ COUNT
0225  5223              JMP .-2
0226  1007              TAD K600            / RESET STORE.
0227  3001              DCA STORE
0230  4107              JMS CRLF
0231  1115              TAD M2000           / SET TIMER TO TEST HSR.
0232  3005              DCA DELAY
0233  6014              RFC
0234  6011  CHECK,      RSF                 / HIGH SPEED READER READY ?
0235  7410              SKP
0236  5242              JMP FAST            / YES !
0237  2005              ISZ DELAY
0240  5234              JMP CHECK
0241  7410              SKP                 / NO, IP DEVICE = TELETYPE.
0242  7001  FAST,       IAC
0243  3117              DCA RFLAG           / 1=HSR, 0=TTY.
0244  3121              DCA RECORD          / CLEAR RECORD COUNTER.
0245  7040  RSTRT,      CMA
0246  3122              DCA CONTRL          / SET WORD PT. TO -1.
0247  3131              DCA FLAG
0250  1001              TAD STORE           / COPY NEW RECORD ADDRESS.
0251  3002              DCA STORE+1
0252  4516  INPUT,      JMS I READX         / READ A CHARACTER.
```

```
0253  1123            TAD M37
0254  7450            SNA                     / CHARACTER = "←" ?
0255  5306            JMP ERASE               / YES, LOOSE CURRENT RECORD.
0256  1134            TAD K40
0257  7650            SNA CLA                 / CHARACTER = CR.
0260  5312            JMP IPTERM              / YES, END OF RECORD.
0261  1122            TAD CONTRL
0262  7650            SNA CLA                 / IP TO SENIOR OR JUNIOR END ?
0263  5274            JMP JUNIOR
0264  3122            DCA CONTRL              / CLEAR IP POINTER.
0265  1133            TAD INCOME
0266  7106            CLL RTL
0267  7006            RTL
0270  7006            RTL
0271  3401            DCA I STORE             / STORE IN SENIOR END.
0272  2131            ISZ FLAG
0273  5252            JMP INPUT
0274  1133  JUNIOR,    TAD INCOME
0275  1401            TAD I STORE             / ADD NEW JUNIOR TO OLD SENIOR
0276  3401            DCA I STORE
0277  2001            ISZ STORE               / INCREMENT STORE.
0300  7100            CLL
0301  1001            TAD STORE
0302  1125            TAD MTOP
0303  7620            SNL CLA                 / STORE FULL ?
0304  5374            JMP PRESET              / NO.
0305  5317            JMP STANBY              / YES, ENTER SORT.
0306  7200  ERASE,     CLA
0307  1002            TAD STORE+1
0310  3001            DCA STORE
0311  5245            JMP RSTRT
0312  5161  IPTERM,    JMP KV2
0313  1147            TAD RECLEN
0314  1002            TAD STORE+1             / MOVE STORE FOR NEXT RECORD.
0315  3001            DCA STORE
0316  5245            JMP RSTRT
0317  1002  STANBY,    TAD STORE+1
0320  3150            DCA SORTH               / COPY END OF STORE FOR SORT
0321  4526            JMS I SORTIT            / ENTER SORT SUBROUTINE.
0322  7402            HLT
0323  7604            LAS                     / READ REQUIRED OP DEVICE FROM
0324  0127            AND K1                  / 1=HSP, 0=TTY.
0325  3120            DCA PFLAG
0326  1130            TAD M120
0327  3003            DCA COUNT
0330  4042            JMS OUT                 / PUNCH LEADER.
0331  2003            ISZ COUNT
0332  5330            JMP .-2
0333  4101            JMS OCRLF               / PUNCH CR-LF.
0334  1121            TAD RECORD
```

```
0335  7041                CIA
0336  3121                DCA RECORD          / COMPLIMENT NO. OF RECORDS.
0337  1007                TAD K600
0340  3001                DCA STORE
0341  1001  INDEX,        TAD STORE
0342  3002                DCA STORE+1         / COPY STORE.
0343  1147                TAD RECLEN          / SET UP WORD COUNT.
0344  5155                JMP XKP
0345  3003                DCA COUNT
0346  1401  NEXT,         TAD I STORE
0347  7112                CLL RTR
0350  7012                RTR
0351  7012                RTR                 / ROTATE SENIOR FOR O.P.
0352  4020                JMS UNTRIM
0353  1401                TAD I STORE         / PUNCH.
0354  4020                JMS UNTRIM          / SET JUNIOR.
0355  2001                ISZ STORE           / PUNCH.
0356  5346                JMP NEXT
0357  4101  EOR,          JMS OCRLF
0360  1147                TAD RECLEN          / PUNCH CR-LF.
0361  1002                TAD STORE+1         / SET STORE TO NEW RECORD.
0362  3001                DCA STORE
0363  2121                ISZ RECORD
0364  5341                JMP INDEX           / INCREMENT RECORD COUNT.
0365  1130                TAD M120
0366  3003                DCA COUNT           / ALL RECORDS OUT !
0367  4042                JMS OUT
0370  2003                ISZ COUNT           / PUNCH TRAILER.
0371  5367                JMP .-2
0372  7402                HLT
0373  5217                JMP START           / END.
0374  7040  PRESET,       CMA                 / REPEAT FOR SAME CONDITIONS.
0375  3122                DCA CONTRL
0376  5252                JMP INPUT
```

```
/ SORT SUBROUTINE FOR FIXED NUMBER OF RECORDS.
/ RECLEN = RECORD LENGTH.
/ SORLEN = NUMBER OF WORDS PER RECORD TO BE SORTED ON.
/ SORTL  = LOC. CONTAINING 1 ST. WORD OF 1ST. RECORD.
/ SORTH  = LOC+1  CONTAINING LAST WORD OF LAST RECORD.

/ PAGE 2.
*400
0400  0000  SORT,       0
0401  7200              CLA
0402  1152              TAD SORLEN
0403  7041              CIA
0404  1147              TAD RECLEN
```

```
0405  7710          SPA CLA
0406  7402          HLT
0407  1151  SET,    TAD SORTL       / SET UP CURRENT RECORD POINTER
0410  3365          DCA REC1
0411  1151          TAD SORTL
0412  1147          TAD RECLEN
0413  7000          NOP             / SET UP CURRENT RECORD+1 POINTER
0414  3367          DCA REC2
0415  1150          TAD SORTH       / SET UP WORK AREA.
0416  3363          DCA BUFFA
0417  1147          TAD RECLEN      / SET UP RECORD ELEMENT COUNTER
0420  7041          CIA
0421  3364          DCA MRELEN
0422  5230          JMP GEREDY
0423  1151          TAD SORTL
0424  7041          CIA
0425  1365          TAD REC1
0426  7710          SPA CLA
0427  5207          JMP SET         / COPY CURRENT RECORD ADDRESSES
0430  1365  GEREDY, TAD REC1
0431  3366          DCA REC1+1
0432  1365          TAD REC1
0433  1153          TAD SORST
0434  3365          DCA REC1
0435  1367          TAD REC2
0436  3370          DCA REC2+1
0437  1367          TAD REC2
0440  1153          TAD SORST
0441  3367          DCA REC2
0442  1152          TAD SORLEN
0443  7041          CIA
0444  3372          DCA ZERCOT      /COMPARE RECORD AND RECORD+1.
0445  1765  COMPR,  TAD I REC1
0446  7141          CIA CLL
0447  1767          TAD I REC2
0450  7450          SNA             / ELEMENTS WITHIN RECORDS ARE=
0451  5335          JMP ZERO
0452  7630          SZL CLA         / RECORDS ARE IN THE RIGHT ORD
0453  5341          JMP OK          / RECORDS ARE IN THE WRONG ORD
0454  1364          TAD MRELEN      / CHANGE ROUND RECORD AND REC
0455  3371          DCA COUNTA
0456  4355  CHANGE, JMS RESET
0457  1765          TAD I REC1
0460  3763          DCA I BUFFA
0461  2365          ISZ REC1
0462  2363          ISZ BUFFA
0463  2371          ISZ COUNTA
0464  5257          JMP CHANGE+1
0465  1364          TAD MRELEN
0466  1365          TAD REC1
```

```
0467  3365
0470  1364            DCA REC1
0471  1363            TAD MRELEN
0472  3363            TAD BUFFA
0473  1364            DCA BUFFA
0474  3371            TAD MRELEN
0475  1767  MOOV,     DCA COUNTA
0476  3765            TAD I REC2
0477  2367            DCA I REC1
0500  2365            ISZ REC2
0501  2371            ISZ REC1
0502  5275            ISZ COUNTA
0503  1364            JMP MOOV
0504  1365            TAD MRELEN
0505  3365            TAD REC1
0506  1364            DCA REC1
0507  1367            TAD MRELEN
0510  3367            TAD REC2
0511  1364            DCA REC2
0512  3371            TAD MRELEN
0513  1763  COPIE,     DCA COUNTA
0514  3767            TAD I BUFFA
0515  2367            DCA I REC2
0516  2363            ISZ REC2
0517  2371            ISZ BUFFA
0520  5313            ISZ COUNTA
0521  1364            JMP COPIE
0522  1367            TAD MRELEN
0523  3367            TAD REC2
0524  1364            DCA REC2
0525  1363            TAD MRELEN
0526  3363            TAD BUFFA
0527  1365            DCA BUFFA
0530  3367            TAD REC1
0531  1365            DCA REC2
0532  1364            TAD REC1
0533  3365            TAD MRELEN
0534  5223            DCA REC1
0535  2365  ZERO,     JMP GEREDY-5
0536  2367            ISZ REC1        / MOVE POINTER TO NEXT RECORD
0537  2372            ISZ REC2
0540  5245            ISZ ZERCOT      /       (WITHIN SORT KEY)
0541  4355  OK,       JMP COMPR
0542  1367            JMS RESET       / RECORDS ARE IN THE RIGHT ORD
0543  3365            TAD REC2        /  MOVE TO NEXT PAIR.
0544  1367            DCA REC1
0545  1147            TAD REC2
0546  3367            TAD RECLEN
0547  1150            DCA REC2
0550  7141            TAD SORTH
                      CIA CLL
```

```
                        TAD REC2
0551  1367              SZL CLA
0552  7630              JMP I SORT
0553  5600              JMP GEREDY
0554  5230

                                          / RESET RECORD POINTERS.
0555  0000  RESET,      0
0556  1366              TAD REC1+1
0557  3365              DCA REC1
0560  1370              TAD REC2+1
0561  3367              DCA REC2
0562  5755              JMP I RESET

0563  0000  BUFFA,      0
0564  0000  MRELEN,     0
0565  0000  REC1,       0
0566  0000              0
0567  0000  REC2,       0
0570  0000              0
0571  0000  COUNTA,     0
0572  0000  ZERCOT,     0
```

```
                / PAGE 3.
                *600

                / SUBROUTINE TO READ A CHARACTER.

0600  0000  READ,      0
0601  7200              CLA
0602  1117              TAD RFLAG
0603  7650              SNA CLA
0604  5234              JMP SLOW
0605  4073              JMS HSK
0606  3133  OKIN,       DCA INCOME
0607  1133              TAD INCOME
0610  7450              SNA                     / CHARACTER = 0 ?
0611  5201              JMP READ+1
0612  1140              TAD M377
0613  7450              SNA                     / CHARACTER = RUBBOUT ?
0614  5201              JMP READ+1
0615  1141              TAD K133
0616  7450              SNA                     / CHARACTER = $ ?
0617  5542              JMP I DOLLAR
0620  1143              TAD K27
0621  7450              SNA                     / CHARACTER = CR ?
0622  5236              JMP LOOSE
0623  1144              TAD K3
0624  7650              SNA CLA                 / CHARACTER = LF ?
0625  5201              JMP READ+1
```

```
0626  7200  HOLD,   CLA
0627  1133          TAD INCOME
0630  0132          AND K77
0631  3133  HOP,    DCA INCOME
0632  1133          TAD INCOME
0633  5600          JMP I READ
0634  4066  SLOW,   JMS SSR
0635  5206          JMP OKIN
0636  7040  LOOSE,  CMA
0637  5231          JMP HOP
0640  0000          0
0641  0000  DATA,   0
```

```
AUTO    0010
BLANK   0037
BUFFA   0563
CALL    0033
CHANGE  0456
CHECK   0234
COMPR   0445
CONTRL  0122
COPIE   0513
COUNT   0003
COUNTA  0571
CRLF    0107
DATA    0641
DELAY   0005
DOLLAR  0142
EOR     0357
ERASE   0306
FAST    0242
FLAG    0131
GEREDY  0430
HOLD    0626
HOP     0631
HSR     0073
INCOME  0133
INDEX   0341
INPUT   0252
IPTERM  0312
JUNIOR  0274
K V2    0161
K1      0127
K100    0135
K1040   0124
K133    0141
K200    0136
K212    0146
K215    0145
K240    0154
```

```
K27         0143
K3          0144
K40         0134
K577        0006
K600        0007
K77         0132
LOOSE       0636
MOOV        0475
MRELEN      0564
MTOP        0125
M120        0130
M2000       0115
M37         0123
M377        0140
NEXT        0346
OCRLF       0101
ODT         0004
OK          0541
OKIN        0606
OUT         0042
PFLAG       0120
PRESET      0374
READ        0600
READX       0116
RECLEN      0147
RECORD      0121
REC1        0565
REC2        0567
RESET       0555
RFLAG       0117
RSTRT       0245
SET         0407
SLOW        0634
SORLEN      0152
SORST       0153
SORT        0400
SORTH       0150
SORTIT      0126
SORTL       0151
SSR         0066
STANBY      0317
START       0217
STORE       0001
TTY         0055
TYPE        0060
UNTRIM      0020
XEOR        0137
XKP         0155
ZERCOT      0572
ZERO        0535
```